Microburst Windspeed Potential Assessment: Progress and Recent Developments

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1. INTRODUCTION

A new diagnostic nowcasting product, the **Microburst Windspeed Potential Index (MWPI)** (Pryor 2008), has been developed to quantify the most relevant factors in convective downburst generation. The MWPI is based on a predictive linear model that incorporates **CAPE**, the **sub-cloud lapse rate** and the **dew point depression difference** between the typical level of a convective cloud base near 670 mb and the sub-cloud layer at 850 mb. The MWPI accounts for both updraft (**U**) and downdraft instability (**D**) in microburst generation:

$$MWPI \equiv \underbrace{\{(CAPE/100)\}}_{U} + \underbrace{\{\Gamma + (T-T_d)_{850} - (T-T_d)_{670}\}}_{D}$$

where Γ is the lapse rate in degrees Celsius (C) per kilometer from the 850 to the 670 mb level, and the quantity $(T-T_d)$ is the dewpoint depression (C). The prototype sounding profile that illustrates the MWPI algorithm is displayed in Figure 1.

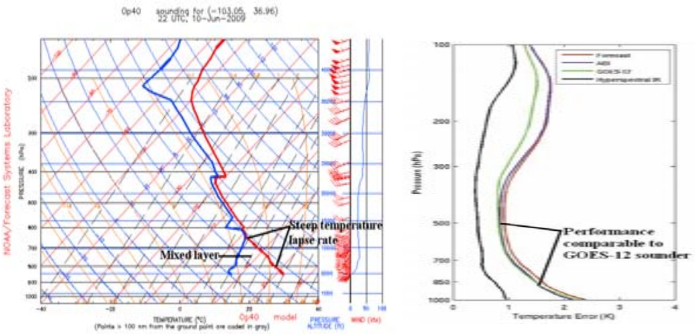

Figure 1. Prototypical "Inverted V" sounding profile, derived from Rapid Update Cycle (RUC) model analysis data at Kenton, Oklahoma at 2200 UTC 10 June 2009 (left), and temperature error curves for NWP forecast, ABI, GOES-12, and Hyperspectral IR soundings (courtesy Schmit et al. (2008), right).

Derivation of the MWPI algorithm is primarily based on **parameter evaluation** and **pattern recognition** techniques as employed in the **severe convective storm forecasting** process (Johns and Doswell 1992). Output is **categorical** with index values corresponding to categories of wind gust potential: <35 knots, 35 to 49 knots, 50 to 64 knots, and >64 knots. Index values, color-coded according to wind gust potential category, are plotted over **CONUS GOES imagery.**

Although there is not currently an observational requirement for microburst potential for the GOES-R Advanced Baseline Imager (ABI), the **ABI does have promising capability to generate a sounding profile with greatly improved temporal and spatial resolution as compared to the existing GOES (8-P) sounders. In addition, Schmit et al. (2008)** show in Figure 1 that both the **ABI and the current sounder provide slightly improved temperature information compared to the NWP forecast**. The error curves in Figure 1 show that the ABI sounding offers a comparable performance to the GOES-12 sounding with a slight improvement to the temperature profile below the 850mb level. This finding underscores the importance of the 700 to 850mb level in the assessment of downdraft instability.

2. CASE STUDY: 30 June 2009 Oklahoma Downbursts

During the afternoon of **30 June 2009**, strong convective storms developed along a weak cold front as it was tracking southward over Oklahoma. The pre-convective environment downstream of the cold front over western Oklahoma was dominated by vertical mixing that fostered the development and evolution of a convective boundary layer. Elevated Geostationary Operational Environmental Satellite (GOES) Microburst Windspeed Potential Index (MWPI) values in the vicinity of downburst occurrence over western Oklahoma served as evidence of the presence of a well-developed mixed layer. Strong downbursts that were recorded by Oklahoma Mesonet stations between 2100 UTC and 0000 UTC 1 July resulted from sub-cloud evaporation of precipitation.

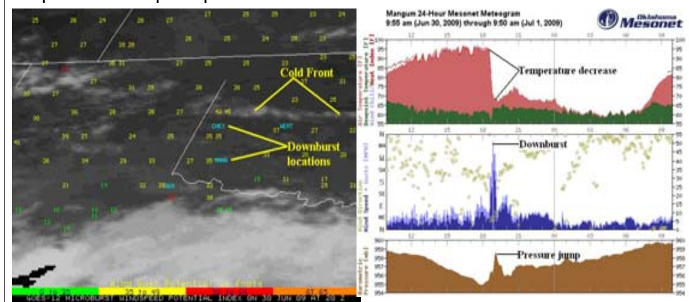

Figure 2. GOES MWPI product image at 2000 UTC 30 June 2009 (left) and an Oklahoma Mesonet meteogram at Mangum (right).

The meteogram at Mangum, Oklahoma above displays surface characteristics of the strongest downburst that occurred at Mangum at 2350 UTC. Classic downburst signatures are apparent in the meteogram including a sharp peak in wind speed (51 mph/44 knots), significant temperature decrease (27F), and a pressure jump of 4 millibars (mb).

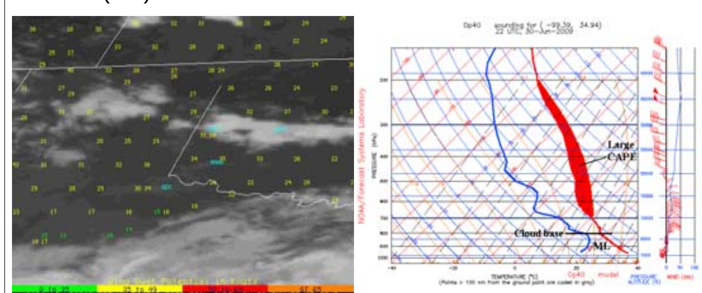

Figure 3. GOES MWPI product image (left) and RUC sounding profile at Mangum, Oklahoma (right) at 2200 UTC 30 June 2009. Elevated risk values indicated the presence of large CAPE, a dry mixed layer (ML), and subcloud layer with a steep temperature lapse rate that favored the development of intense downdrafts due to the evaporation of precipitation and resulting negative buoyancy. This favorable environment was most effectively shown in the above RUC sounding profile over Mangum at 2200 UTC.

3. METHODOLOGY AND VALIDATION

The objective of this validation effort was to **qualitatively and quantitatively assess** the performance of the **GOES MWPI product** by employing classical statistical analysis of real-time data as illustrated in Figure 4. Data from the **GOES MWPI** product was collected over **Oklahoma and western Texas** for downburst events that occurred between **1 June 2007 and 30 June 2009** and validated against **surface observations** of convective wind gusts as recorded by **Oklahoma** and **West Texas Mesonet** (Brock et al. 1995; Schroeder et al. 2005) stations.

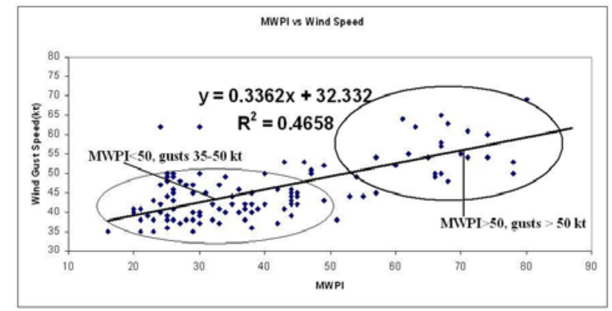

Figure 4. Statistical analysis of validation data over the Oklahoma and western Texas domain between June 2007 and June 2009: Scatterplot of MWPI values vs. measured convective wind gusts for 114 downburst events.

4. REFERENCES

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